HEALTH CONSULTATION

THE FORMER MIRO GOLF COURSE

VILLAGE OF DOUGLAS, ALLEGAN COUNTY, MICHIGAN

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Prepared by

Michigan Department of Community Health
Under a Cooperative Agreement with
Agency for Toxic Substance and Disease Registry

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Abbreviations and Acronyms

$\mu g/m^3$	micrograms per cubic meter
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
Cis-1,2-DCE	cis-1,2-dichloroethene
CREG	Cancer Risk Evaluation Guide
CV	Comparison Value
DCC	Direct Contact Criteria
DWC	Drinking Water Criteria
EMEG	Environmental Media Evaluation Guide
ERD	Environmental Response Division
ERE	Equity Resource Environmental
GCC	Groundwater Contact Criteria
GVIIC	Groundwater Volatilization to Indoor Air Inhalation Criteria
ICP-MS	Inductively-Coupled Plasma Mass Spectrometry
JEM	Johnson-Ettinger Model
MDCH	Michigan Department of Community Health
MDEQ	Michigan Department of Environmental Quality
MDNR	Michigan Department of Natural Resources
MESB	Michigan Environmental Science Board
mg/day	milligrams per day
MRL	Minimal Risk Level
ND	not detected
ppm	parts per million
ppb	parts per billion
RfC	Reference Concentration
SVIIC	Soil Volatilization to Indoor Air Inhalation Criteria
TCE	trichloroethylene
VC	vinyl chloride

Summary

The former Miro Golf Course (Miro) in Douglas, Michigan, is slated for redevelopment into residential and commercial use. The property is adjacent to the former Chase Manufacturing (Chase) facility, now owned by Haworth Furniture (Haworth). Past industrial use of this neighboring property led to contamination of groundwater with trichloroethylene (TCE), the plume extending under the northeast portion of the golf course. Additionally, the golf course was previously a peach orchard, and surface soil samples have revealed arsenic contamination on the property, likely resulting from past horticultural pesticide application.

The TCE contamination under the property poses no health hazard to current users of the property, but poses an indeterminate health hazard to current neighbors and future residents of the property. Indoor air testing might determine whether current neighbors are being exposed to unsafe levels of TCE in their homes. "Due care" construction practices, such as using protective barriers around the house foundation, will prevent future residents from being exposed.

The arsenic contamination on the property poses an indeterminate public health hazard to current users and neighbors and to future residents of the property. Initially, soil arsenic concentrations in the northeast corner of the property exceeded state screening levels. However, subsequent excavation at the site has made previous sampling results void. The soil should be tested again for arsenic. Exposure of construction workers to soil is highly likely. Dust might be generated during construction, causing downwind residents to be exposed. "Due care" measures, such as dust suppression, taken during construction will reduce or prevent potential exposure. If any contaminated soil is removed from the site, no future health hazard will exist.

Purpose and Health Issues

This health consultation is designed to assess the public health implications associated with TCE-contaminated groundwater under and arsenic-contaminated soil on the former Miro Golf Course in the village of Douglas, Allegan County, Michigan. The Michigan Department of Environmental Quality (MDEQ) and the Allegan County Health Department requested a public health opinion from the Michigan Department of Community Health (MDCH). Under a cooperative agreement, MDCH conducts health assessments and consultations for the federal Agency for Toxic Substances and Disease Registry (ATSDR).

The MDCH and ATSDR consider environmental data, health outcome data, and community health concerns when forming a health opinion. The agencies then use their conclusions to make recommendations to ensure public safety and health. The community health concerns to be addressed in this health consultation are:

1. What is the likelihood that TCE in the groundwater beneath the Miro property could volatilize into the basements of future homes and present a health hazard to the residents of those homes?
2. Does the TCE in the groundwater present a health hazard to neighboring residents?

3. Does the TCE-contaminated groundwater discharging to area surface waters present a health hazard to persons exposed to those waters (e.g., golfers retrieving golfballs, children or dogs playing in the water)?
4. Does the arsenic in the soil at the proposed development site pose a health hazard to construction workers or to future users of the property if the developer constructs a berm as discussed?

Background

The former Miro Golf Course in Douglas, Michigan, is situated immediately west of a manufacturing plant currently owned by Haworth (Figure 1). The plant has a complex ownership and environmental history dating back more than 60 years. Chlorinated solvents, semi-volatile organic compounds, and metals have been identified in the shallow soils beneath and in the immediate vicinity of the plant (Weston 2002). The MDEQ identified Chase, which owned and operated the plant in the 1960s and 1970s, as the "Potentially Liable Party" who is responsible for the contamination (P. Massoth, MDEQ-ERD Kalamazoo District, personal communication, 2002).

The first three owners of the plant produced automotive parts at the facility. Historical aerial photos starting in the early 1950s (when aerial photography was first started) show ponds of liquid wastes outside the doors of the warehouse and around the property. Subsequent aerial photos show a variety of building additions, many placed in the areas of the initial waste ponds, which were relocated to other vacant parts of the property (P. Massoth, MDEQ-ERD Kalamazoo District, personal communication, 2002).

During the early 1960s, Chase and the village of Douglas installed a pipeline to carry effluent from the plant to the Kalamazoo River. The then state Department of Conservation advised the parties that the pipeline was not an approved environmental practice. Chase responded by constructing a wastewater treatment plant on the east side of the facility. Effluent from the treatment plant was piped east to a county drain where it flowed about three city blocks before soaking into the ground. The flow was partially through the elementary school playground. Children at the school called the drain "Chemical Creek" because "it ran all sorts of different colors." Soil sampling in the late 1980s by the Michigan Department of Natural Resources[1] (MDNR) of area residential yards revealed high levels of chromium and other metals. Wickes Manufacturing, which in 1985 had purchased Gulf and Western, the parent company of Chase, funded remediation of the drain in 1989 (P. Massoth, MDEQ-ERD Kalamazoo District, personal communication, 2002).

Following the remediation of "Chemical Creek," MDNR installed additional monitoring wells in the village area, including several around the former Chase facility. (Wells were not installed at the Miro Golf Course.) Initial testing of the assumed up-gradient well in 1989 contaminated the sampling pump with TCE, and the highest concentration of the chemical was detected at this location. The wells were resampled with disposable

[1]As of October 1, 1995, the environmental protection and regulation functions of the Michigan Department of Natural Resources (MDNR) were transferred to the newly-formed Michigan Department of Environmental Quality (MDEQ).

bailers, which provided a more representative picture of the contamination (P. Massoth, MDEQ-ERD Kalamazoo District, personal communication, 2002). Haworth designed and built a treatment system in the early 1990s but has not implemented its use because changes to state law in 1994 provided liability relief to owners or operators of contaminated property if they had not caused the contamination (MDEQ 2001a).

Before Miro was used as a golf course, peach trees were grown on the property. Surface soil sampling in 2000 revealed arsenic contamination in the northeast portion of the property (Figure 2) (P. Massoth, MDEQ-ERD Kalamazoo District, personal communication, 2002). Arsenic has been used in the past in horticultural pesticide applications. The application of fruit residuals, if applied according to label directions and according to generally accepted agricultural practices, does not constitute a "release" as defined by Part 201 of the Natural Resources and Environmental Protection Act (MDEQ 2001a). Therefore, previous owners of the property who grew peaches and used arsenicals in managing the orchard are not liable, under state law, for the contamination.

The Miro property has been purchased by a developer who plans to build houses, rental units, and commercial buildings there (Figure 3). Development plans include excavating the contaminated soil, placing it in a berm, capping it with six inches of clean soil, and seeding it to grass. Construction plans do not address the TCE groundwater contamination underlying the property. The MDEQ is planning the remediation of the groundwater (P. Massoth, MDEQ-ERD Kalamazoo District, personal communication, 2002).

The county health department and local residents living adjacent to the proposed development are concerned that TCE levels in the groundwater and arsenic levels in the surface soil might pose a health threat to current neighbors or future residents of the property. On January 25, 2002, the Allegan County Health Department contacted MDCH about the proposed "Beachside Village" development to be built on the former Miro Golf Course. There was concern that TCE contamination of the groundwater flowing beneath the property posed a health risk to future residents. Although the development will be served by municipal water and sewage, the health department questioned the possibility of vapor infiltration into the substructures of the homes (W. Hinz, Allegan County Health Department, personal communication, 2002). The maximum 2001 TCE concentration of 81,000 parts per billion (ppb) in the plume exceeded the MDEQ criterion protective of the volatilization to indoor air pathway (MDEQ 2002).

On January 28, 2002, MDCH contacted the MDEQ Environmental Response Division[2] (ERD) district office in Kalamazoo, Michigan, and discussed the contamination under the property. During this communication, MDCH was informed that surface soil samples from Miro contained levels of arsenic exceeding the MDEQ criterion protective of direct soil contact. The MDEQ said that the developer planned to excavate the contaminated

[2] On September 15, 2002, the administrative section of the MDEQ Environmental Response Division joined the newly-formed Remediation and Redevelopment Division and the toxics section joined the newly-formed Environmental Science and Services Division.

soil, mound it into a berm, cover it with clean soil, and seed it with grass. The MDEQ voiced concerns over the builder's decontamination practices, proper training of the workers, and adherence to Michigan Occupational Safety and Health Administration standards (P. Massoth, MDEQ-ERD Kalamazoo District, personal communication, 2002).

On January 28, 2002, several community members submitted a stop-action request to the Douglas village council to stop work on the development. The council did not act upon the request but chose instead to hold a public meeting on February 7, 2002. Representatives for the developer, the village of Douglas, the Allegan County Health Department, MDEQ, and MDCH were present to answer questions and share information.

On January 29, 2002, a citizen of Douglas who lives in a development immediately west of the Miro property contacted MDCH. The citizen was concerned that the TCE contamination might pose a health threat both to the residents of his subdivision, which is served by municipal water and sewage, as well as to future residents of the proposed development. He asked whether a risk assessment had been performed on the proposed future use of the property (citizen of Douglas, personal communication, 2002).

On February 7, 2002, MDCH attended a public information meeting hosted by the Douglas village council. Citizens not only expressed concern about the contamination on and under Miro but also wanted information about the likelihood of off-site contamination and exposure, specifically in the Wilderness Ridge subdivision immediately west of Miro, on West Shore Golf Course immediately north across Center Street, and in areas where Wick's Creek, one of the surface waters to which the groundwater discharges, flows.

On May 6, 2002, MDCH met with MDEQ and members of the newly formed Health and Environment Committee of Douglas. The meeting allowed representatives of the agencies and the village to meet and enabled MDCH to familiarize the Health and Environment Committee with ATSDR's public health assessment process. Later that same day, MDCH attended the Douglas village council meeting to introduce the health assessor to the council members and to hear MDEQ discuss the environmental data.

Discussion

Environmental Contamination

The sampling results discussed in this consultation were taken from the available investigations of the property and are not adjusted for limitations or bias in the sampling programs. The MDEQ criteria used in the current health consultation are the Residential and Commercial IV Direct Contact Criteria (DCC), Drinking Water Criteria (DWC), Groundwater Contact Criteria (GCC), and Groundwater Volatilization to Indoor Air Inhalation Criteria (GVIIC), defined below.

DCC: The DCC identifies a soil concentration that is protective against adverse health effects due to long-term incidental (unintentional) ingestion of and dermal exposure to

contaminated soil. (The intentional consumption of non-food material, such as soil, is called pica behavior and is displayed by some children.) Risks posed by inhalation and any physical hazard of the contaminant, such as flammability or explosivity, are not addressed by the DCC (MDEQ 2001c).

The MDEQ Residential DCC assumes that a person is exposed via ingestion to a chemical for 30 years at 350 days per year, that the person will be exposed dermally to the chemical 245 days per year, and that a child aged 1-6 years will eat 200 milligrams per day (mg/day) or an adult will eat 100 mg/day of outdoor soil and indoor dust (MDEQ 2001c).

The MDEQ Commercial IV DCC assumes that the general public has infrequent access to a contaminated site. Instead, workers who have frequent contact with the soil represent the exposed population. The criterion assumes that exposure via ingestion occurs no more than 245 days per year, dermal exposure occurs no more than 160 days per year, the duration of exposure is limited to 21 years, and the worker will eat up to 50 mg/day of soil (MDEQ 2001c).

DWC: The DWC identifies a drinking water concentration safe for long-term, daily, residential consumption. The criterion assumes that an adult is exposed via ingestion to a chemical in water for 30 years at 350 days per year at an ingestion rate of 2 liters per day (MDEQ 1998a).

GCC: The GCC identifies a groundwater concentration that is protective against adverse health effects resulting from dermal exposures to hazardous substances in groundwater such as could be experienced by workers in subsurface excavations. The criterion can also be used as an unofficial screening tool to determine whether contaminated groundwater discharging to surface waters presents a health risk to other individuals. Like the DCC, the GCC is protective only of chronic systemic human health effects and does not address risks posed by inhalation or any physical hazard of the contaminant. Unlike the DCC, it does not address incidental ingestion of the contaminant (MDEQ 2001b).

Because the MDEQ GCC was developed to be protective of utility workers, the criterion assumes that an adult is exposed to a chemical for 21 years at 20 days per year, two hours per day (MDEQ 2001b).

GVIIC: The GVIIC identifies a groundwater concentration that protects occupants from the inhalation of contaminant concentrations in indoor air that may cause adverse health effects. This criterion addresses the migration of hazardous substance vapors from groundwater through soil into buildings. It may not be protective against odors, physical hazards, or ecological impacts. Inhalation exposures resulting from indoor uses of groundwater such as showering, laundry, dishwashing, and cooking are not included in the GVIIC. The criterion assumes that a resident is exposed via this pathway for 30 years at 350 days per year (MDEQ 1998b).

The indoor air inhalation exposure pathway uses assumptions made in the Johnson and Ettinger (1991) Model for Subsurface Vapor Intrusion into Buildings (JEM). MDEQ selected this model as the best available quantitative method for developing indoor air inhalation criteria. Although the JEM only describes contaminant vapor migration in soil, MDEQ characterized the migration of contaminants from groundwater by using a methodology similar to that presented in the American Society for Testing and Materials (ASTM 1995). Assumptions in the JEM include: contaminant sources in groundwater are 115 cm from the top of the foundation floor for residential dwellings; the bottom of the basement floor is 200 cm below grade; and the soil type is sandy-loam (MDEQ 1998b).

The GVIIC was first listed in the MDEQ Part 201 clean-up criteria in 1997 (J. Crum, MDEQ Environmental Sciences and Services Division, personal communication, 2002). Before that, MDEQ did not have screening levels to assess the risk of contaminant-vapor migration from groundwater into indoor air. The agency used contaminant concentrations in groundwater only to assess drinking water.

The MDCH reviewed an evaluation of the GVIIC and Soil Volatilization to Indoor Air Inhalation Criteria (SVIIC) prepared by the Michigan Environmental Science Board (MESB) (Fischer et al. 2001). (The MESB is a governor-appointed panel with various areas of relevant scientific expertise charged to review particular environmental issues and make recommendations to the governor's office.) After reviewing the MESB report and other documents regarding the JEM (Kurz 2000; Obmascik 2002), MDCH concluded that, although the JEM provides a basis on which to determine generic criteria, the model has not received sufficient validation to be certain that the criteria are adequately protective. This issue is addressed further in the Conclusions and Recommendations sections of this document.

TCE

Table 1 shows the concentrations of TCE, cis-1,2-dichloroethene (Cis-1,2-DCE), and vinyl chloride (VC) in groundwater sampled from and near the Miro property. (Cis-1,2-DCE and VC are reported to be the microbial degradation products of TCE in groundwater [ATSDR 1997].) The GVIIC and GCC for each compound are shown in the table as well.

None of the monitoring wells in Table 1 installed before 2002 were located directly on the Miro property. The 1988-1990 sampling locations were in three areas: on the Chase property, across Ferry Street from Miro; along the southwest shore of Kalamazoo Lake, about one-half mile northeast of Miro and upgradient of the property; and at the city garage along 130th Street, about one-half mile east of Miro and upgradient of the property. These locations were chosen because "Chemical Creek" had flowed in this direction and MDEQ initially believed groundwater flowed east and northeast. The MDEQ has since determined that there is a discontinuous clay layer about 15 feet below the former Chase facility. Initially groundwater migrates east for about 150 feet, to where the clay layer ends. The groundwater then migrates downward about 36 feet to the aquifer, which flows northwest bringing contaminants back under the facility and under

the Miro property (P. Massoth, MDEQ-ERD Kalamazoo District, personal communication, 2002).

Seven wells on the Chase property were to have been sampled September 29, 1988, however, the sample from the first well contaminated the pump (at least 180,000 ppb TCE). When the wells were tested in 1989 and 1990, that well contained the highest concentration of TCE (68,000 and 42,970 ppb, respectively).

The 1993 sampling occurred only on the Chase property. The 2001 sampling occurred on the Chase property and at locations adjacent to Miro. Detections occurred near and on the Chase property and also at the sampling location near the intersection of Ferry and Center Streets. Exceedances of MDEQ criteria occurred only at sampling locations near and on the Chase property.

Westshore Consulting, the environmental firm conducting the fieldwork for MDEQ, installed new monitoring wells, including two on the Miro property, for the 2002 sampling. None of these wells was located on the Chase property. The sampling results from this phase of the groundwater investigation were used to determine current conditions of the TCE groundwater contamination and to map the plume.

Figure 4 shows the greatest concentration of the contaminant plume under and around Miro at the Chase property (now owned by Haworth). The plume concentration diminishes as it is drawn toward and discharges into Wick's Creek, on Westshore Golf Course, across Center Street from Miro. Much of the north and east portions of Miro overlay the plume. The plume extends off-site, past Miro's eastern boundary under several residential properties.

Table 2 shows the concentrations of TCE, Cis-1,2-DCE, and VC in samples taken from surface waters in the area (small ponds, Wick's Creek, and the creek's inlet to Kalamazoo Lake) along with the DWC and GCC for those compounds. Although exceedances of DWC exist for all three compounds, these surface waters do not provide drinking water to the community. Sediments from these surface water areas were also tested for the compounds but results did not exceed the MDEQ Residential DCC.

Arsenic

On July 3, 2000, Equity Resource Environmental (ERE), under contract with MDEQ, sampled the soil in 22 locations on the Miro property (Figure 2). Two samples per location were taken, at 3-6 and at 12-15 inches below grade. The samples were analyzed for arsenic content using Inductively-Coupled Plasma Mass Spectrometry (ICP-MS). This sampling was done as follow-up to the findings of a preliminary investigation performed by consultants for Haworth (P. Massoth, MDEQ-ERD Kalamazoo District, personal communication, 2002). Results from the samples taken by ERE ranged from not detected (ND) to 270 parts per million (ppm) in the 3-6 inch depth and ND to 9.2 ppm in the 12-15 inch depth (data not shown). The Residential DCC for arsenic is 7.6 ppm. Six of the samples from the shallower depth and one from the deeper depth exceeded the Residential DCC. The Commercial IV DCC for arsenic is 74 ppm. Two

samples from the shallower depth and none from the deeper depth exceeded the Commercial IV DCC.

On July 26, 2000, ERE sampled 10 additional locations within the northeast corner of the property, where the initial exceedances were found. One sample was taken per location, at a depth of 3-6 inches. The results for all 10 samples exceeded the Residential DCC for arsenic, ranging from 9.8 to 160 ppm. Four samples exceeded the Commercial IV DCC.

Human Exposure Pathways

To determine whether nearby residents are, have been, or are likely to be exposed to contaminants associated with a property, ATSDR and MDCH evaluate the environmental and human components that could lead to human exposure. An exposure pathway contains five major elements: (1) a source of contamination, (2) contaminant transport through an environmental medium, (3) a point of exposure, (4) a route of human exposure, and (5) a receptor population. An exposure pathway is considered complete if all five elements are, have been, or will be present at the property. Alternatively, an exposure pathway is considered complete if probability of exposure is high. A pathway is considered either potential or incomplete if no evidence exists that at least one of the elements above is, has been, or will be present at the property, or if the probability of exposure is low. The table below shows the exposure pathways expected for the Miro property:

Source	Environmental Transport and Media	Chemicals of Interest	Exposure Point	Exposure Route	Exposed Population	Time Frame	Status
Disposal practices of past industries adjacent to Miro	Groundwater (on-site)	TCE, Cis-1,2-DCE, VC	Indoor air	Inhalation	Future residents of Miro property	Past	Incomplete
						Present	Incomplete
						Future	Potential
Disposal practices of past industries adjacent to Miro	Groundwater (off-site)	TCE, Cis-1,2-DCE, VC	Indoor air	Inhalation	Neighbors of Miro property	Past	Potential
						Present	Potential
						Future	Potential
Disposal practices of past industries adjacent to Miro	Groundwater (off-site)	TCE, Cis-1,2-DCE, VC	Private wellwater	Dermal, ingestion, inhalation	Neighbors of Miro property	Past	Potential
						Present	Incomplete
						Future	Incomplete
Disposal practices of past industries adjacent to Miro	Groundwater (off-site)	TCE, Cis-1,2-DCE, VC	Surface waters	Dermal, ingestion, inhalation	Waders in and users of creek and lake	Past	Potential
						Present	Potential
						Future	Potential
Historical application of arsenical pesticides	Soil	Arsenic	Soil	Dermal, ingestion, inhalation	Construction workers, neighbors, future residents of Miro property	Past	Potential
						Present	Potential
						Future	Potential

The pathway of chemicals volatilizing from groundwater to indoor air is not well-understood. Based on the GVIIC criterion alone, several areas on the Miro property are located over groundwater concentrations of concern. However, more information, such as data from indoor air testing and soil gas monitoring, is necessary to determine whether the concentrations of TCE in the groundwater beneath the Miro property pose a health hazard to current neighbors or future residents of the property via the indoor air inhalation exposure pathway.

Most of the homes north of Chase on Ferry Street have been served by municipal water supplies since they were built. Therefore, residents of those homes have not been and are not now exposed to the TCE via water from private wells. However, immediately north of the plant is a farmhouse, still occupied, that was built in 1872. Until that house was connected to municipal water, the people living there could have used water contaminated with TCE. (Conversations with the owners and Kalamazoo Lake Sewer and Water have not revealed when the connection to the municipal supply was made.) Because of its early construction, the house has what is called a "Michigan cellar," which is essentially an unlined dirt basement. Therefore, no barrier exists to prevent or reduce volatilization of any soil gases into the indoor air. The current isopleth of the TCE plume indicates that contamination is present under the house. The GVIIC cannot be applied in this situation, however, because the criterion includes only buildings with cement substructures. This issue is addressed further in the Conclusions and Recommendations sections of this document.

Table 2 shows the concentrations of TCE, cis-1,2-DCE, and VC in samples taken from surface waters in the area (small ponds, Wick's Creek, and the creek's inlet to Kalamazoo Lake). Exposure to these surface waters would occur to golfers entering Wick's Creek to retrieve golfballs, to children and pets wading in the creek or pond, or to persons using Kalamazoo Lake near where the creek empties into it. The creek is not a source of drinking water, and occasional swallowing of creek water would not be expected to cause any adverse health effects related to TCE exposure. Any dermal contact would be less than the contact assumptions used in the development of the GCC (2 hours per day, 20 days per year for 21 years) and would not be expected to cause adverse health effects.

Current ATSDR guidance suggests that surficial soil sampling should occur only in the top inch of soil. The soil samples from Miro were taken at 3-6 inches depth and may not have been representative of the soil above. During clearing of and construction on the property, workers could be exposed to elevated levels of arsenic in the soil. Proposed construction activities will result in earth being excavated, piled into a berm, and then capped with clean soil and seeded with grass. This could either cause dilution of the arsenic contamination or create localized hotspots in the berm. Although the cap and attendant deed restrictions would afford some protection, a risk would remain that someone would dig in the berm to obtain soil or to insert posts for signs, fences, or lights. A breach of the cap could result in exposure to elevated levels of arsenic.

One assumption MDEQ used to develop the Commercial IV DCC is that a worker (e.g., a groundskeeper) would ingest no more than 50 grams of soil per day at the worksite. Considering the extensive construction work proposed for the Miro property, a worker would likely ingest more soil per day than the default value. Therefore, the criterion may not be adequately protective in this scenario.

Toxicological Evaluation

TCE

TCE is a nonflammable, colorless liquid at room temperature with a somewhat sweet odor and a sweet, burning taste. It is used mainly as a solvent to remove grease from

metal parts. (The biggest source of TCE in the environment is evaporation from factories that use it as a degreaser.) TCE can also be found in some household products, including typewriter correction fluid, paint removers, adhesives, and spot removers (ATSDR 1997).

TCE evaporates easily but can stay in soil and groundwater. Most TCE in water will evaporate into the air. The chemical takes days to weeks to break down in surface water. The breakdown is much slower in groundwater because of the much slower evaporation rate. Very little TCE breaks down in soil, and it can pass through soil into underground water (ATSDR 1997).

The ATSDR establishes Minimal Risk Levels (MRLs) for chemicals to which people may be exposed by inhalation or ingestion. An MRL is an estimate of daily human exposure to a substance that is likely to be without an appreciable risk of adverse (noncancer) effects over a specified exposure duration: *acute* (up to two weeks), *intermediate* (two weeks to one year), or *chronic* (greater than one year). The MRL for *acute* exposure to TCE in air is 2,000 ppb (10,748 micrograms per cubic meter [$\mu g/m^3$]) and for *intermediate* exposure is 100 ppb (537 $\mu g/m^3$; ATSDR 2002a). The odor threshold is 100 ppb (ATSDR 1997). No *chronic* MRL for TCE exists, however the current U.S. EPA Reference Concentration (RfC) for TCE is 40 $\mu g/m^3$ (7.4 ppb; ATSDR 2002). (An RfC is a 24-hour air concentration that, with uncertainty spanning perhaps an order of magnitude, is not expected to cause adverse health effects over a person's lifetime.) Persons on or near the Miro site are not expected to be exposed to concentrations of TCE greater than the acute or intermediate MRL. As well, any exposure duration would likely be chronic. Predicting what the indoor air concentration might be in a house situated above the TCE-contaminated groundwater plume is difficult. Actual indoor air sampling and analysis would provide a better indication of what concentrations, if any, exist in the house.

TCE was once used as an anesthetic for surgery. Persons exposed to high concentrations of TCE can become dizzy or sleepy and, at very high levels, may lose consciousness. However, persons on or near the Miro site would not likely be exposed to high levels of TCE. Persons who breathe moderate levels of TCE may experience headaches or dizziness. Exposure to TCE has been associated with several forms of cancer. These associations are based primarily on occupational data, in which workers were exposed to higher concentrations than would normally be found at sites of environmental contamination. Workers were exposed to other chemicals in addition to TCE, and those exposures may confound the data. Because the likelihood of TCE migration into indoor air in homes around Miro is not known, predicting whether persons in those homes have an increased risk of cancer is difficult.

Arsenic

Arsenic is a naturally occurring element that is widely distributed in the earth's crust. Some nutritional studies indicate that arsenic may be a nutrient essential for good health. Inorganic arsenic compounds are used mainly to preserve wood. Organic arsenic compounds are used as pesticides, primarily on cotton plants (ATSDR 2000).

To provide screening levels, ATSDR establishes Comparison Values (CVs), estimated concentrations of chemicals in specific media that are not likely to cause adverse (noncancer) health effects,. If an environmental concentration exceeds its corresponding CV, the chemical of interest is evaluated further. The chronic Environmental Media Evaluation Guide (EMEG) for arsenic in soil is 20 ppm for a child and 200 ppm for an adult (ATSDR 2002b). Four soil samples taken from the shallower depth at Miro on July 3 and eight samples taken July 26, 2000, exceeded the child chronic EMEG. Only one sample, taken from the shallower depth on July 3, 2000, exceeded the adult chronic EMEG.

Perhaps the single most common and characteristic sign of oral exposure to inorganic arsenic is the appearance of skin ailments: hyperkeratinization (thickening) of the skin, especially on the palms and soles; formation of multiple hyperkeratinized corns or warts; and hyperpigmentation (darkening, usually a speckled pattern) of the skin with some hypopigmentation (loss of pigmentation). These effects are usually the earliest observable signs of chronic (long-term) exposure to arsenic (ATSDR 2000). Other symptoms of chronic arsenic toxicity include sensory effects, such as particularly painful dysesthesia (an unpleasant, abnormal sensation) or a "pins and needles" sensation, which occur earlier in the progression of symptoms. A reversible bone marrow depression may occur. Anemia is common in chronic arsenic toxicity (ATSDR 1990). If the contaminated soil at Miro is placed in a berm and capped with clean soil and sod (as the developer proposes), *and* remains undisturbed, future users of the property would not be exposed to elevated concentrations of arsenic in the soil and adverse health effects would not occur.

Direct dermal contact with arsenic might cause local irritation and contact dermatitis. The effects may be mild but might progress to papules (inflamed pimples) and vesicles (blisters or cysts) in extreme cases (ATSDR 2000). Construction workers at the Miro property could be exposed to high levels of arsenic in the soil during clearing and building activities. Also, potentially arsenic-containing dust could be generated during construction work. Breathing this dust might cause nose or throat irritation. As mentioned previously, if the arsenic-contaminated soil is placed in a berm, capped, and remains undisturbed, then future users of the property would not be exposed.

Inorganic arsenic has been classified as a human carcinogen (EPA 1998). Several studies have shown that ingestion of arsenic in drinking water can increase the risk of various forms of cancer; however, this is not an exposure pathway at this site. Long-term ingestion of soil containing arsenic might increase the risk of skin cancer (ATSDR 2000). As mentioned previously, if the arsenic-contaminated soil is sequestered, then exposure will not occur.

Breathing dust that contains high levels of arsenic, such as would be found in an industrial setting, might increase the risk of lung cancer (ATSDR 2000). The ATSDR Cancer Risk Evaluation Guide (CREG) for arsenic in air is 0.0002 $\mu g/m^3$ (ATSDR 2002a). No measurements of arsenic in the air have been taken at the Miro property.

The likely generation of dust during construction activities could lead to exposure to elevated levels of arsenic in the air, but dust-suppression measures should prevent that.

ATSDR Child Health Initiative

Children may be at greater risk than are adults from exposure to hazardous substances at sites of environmental contamination. Children engage in activities such as playing outdoors and hand-to-mouth behaviors that could increase their intake of hazardous substances. They are shorter than are most adults, and therefore breathe dust, soil, and vapors closer to the ground. Their lower body weight and higher intake rate result in a greater dose of hazardous substance per unit of body weight. The developing body systems of children can sustain permanent damage if toxic exposures are high enough during critical growth stages. Even before birth, children are forming the body organs they need to last a lifetime. Injury during key periods of growth and development could lead to malformation of organs (teratogenesis), disruption of function, and premature death. Exposure of the mother could lead to exposure of the fetus via the placenta, or injury or illness sustained by the mother could affect the fetus (ATSDR 1998). The obvious implication for environmental health is that children can experience substantially greater exposures than can adults to toxicants that are present in soil, water, or air.

If groundwater concentrations of TCE are high enough and a pathway exists into the substructure of the house (i.e., a crack in the foundation or a "Michigan cellar"), children who live in homes that are situated over the TCE groundwater plume, currently or in the future, might be at risk of exposure to unacceptable levels of that chemical's vapors in indoor air. Children who currently play on the Miro property might be at risk of exposure to high levels of arsenic in the soil, particularly in the northeast corner of the property. During construction activities, any dust generated on the property might pose an inhalation hazard, especially to asthmatic children.

Community Health Concerns

Several citizens have inquired about indoor-air testing in off-site homes situated over or near the plume. The Douglas Health and Environmental Committee has arranged for the testing of the indoor air in the previously mentioned farmhouse with the Michigan cellar. The MDCH has discussed with MDEQ the possibility of testing existing homes to verify predictions of the JEM.

One person asked whether the myopathy he was experiencing could be caused by exposure to arsenic-contaminated dust from the site. As mentioned earlier in this document, exposure to arsenic can result in a "pins and needles" sensation in the extremities. The MDCH suggested that the man discuss with his personal physician urine testing for arsenic to determine whether he had been exposed to elevated levels of the metal. However, if test results indicated exposure had occurred, it would not necessarily mean that the source was the soil from Miro.

Questions were raised about TCE in area surface waters and the risk of dermal contact with those waters. Concentrations of TCE in groundwater are greatly reduced by the time water reaches the surface. Also, contact with the surface water would be infrequent.

Therefore, dermal contact with surface waters that might contain TCE is not of concern. Any TCE volatilizing from surface waters would be minimal and disperse quickly in ambient air and would not, therefore, be of concern.

One citizen asked whether the contamination could be corrected via phytoremediation (the use of plants to remediate contaminated sites). Selection of remediation alternatives is MDEQ's purview. The selection will depend on future land use as well as feasibility and cost.

Conclusions

The TCE contamination in the groundwater under and around Miro currently poses no health hazard to on-site users of the property because exposure is not occurring. However, because the plume is situated under off-site houses, the health hazard to residents of those houses is indeterminate. The GVIIC assumes that chemicals volatilizing from groundwater can migrate through cracks in the basement foundation of a house. Such cracks might be invisible to the naked eye. Indoor air testing of suspect homes might reveal whether TCE vapors are entering the indoor air and if the concentrations are unacceptable. Testing of soil gas may also be useful in predicting vapors that could migrate from contaminated soil or groundwater into a house.

The health hazard posed to future on-site users of the property by TCE in the groundwater is indeterminate. The likelihood of TCE volatilizating from the groundwater to indoor air is not clear. As previously mentioned, testing of soil gas may provide sufficient information to predict whether vapors would migrate into houses. If new houses are built as planned, "due care" measures taken during construction would prevent any vapors from migrating through cracks. "Due care" requirements for owners of contaminated property are not related to the owner's liability (if any) for the contaminants but are precautions to ensure that existing contamination does not cause unacceptable risks and is not exacerbated.

The arsenic contamination on the Miro property poses an indeterminate public health hazard to current users of the property. Construction workers might be exposed dermally to elevated concentrations of arsenic in the soil, might unintentionally ingest contaminated soil during the workday, and might be exposed to arsenic-contaminated dust. Because access to the site is not restricted, other persons might be similarly exposed at the site. Neighbors downwind of the site might be exposed to arsenic-contaminated dust generated by construction activities. However, excavation has already occurred on the property and it is not known where the arsenic-containing soil currently is or what the concentrations are. A new round of soil testing would determine where the contamination is and at what level.

Any future health hazard related to the arsenic at the site is indeterminate. If the arsenic-containing soil remains on-site but is placed in a berm and capped, no exposure is likely *if* the cap is not compromised. If the contaminated soil is removed from the site, no exposure will occur.

Recommendations

1. Contamination of the groundwater should be addressed with any remedial actions taken appropriate to the proposed land use. The MDEQ should consider calculating a site-specific GVIIC and conducting active soil-gas monitoring and indoor air testing in existing homes. Site-specific parameters to adjust for the GVIIC calculation include soil type and depth to groundwater. Results from soil-gas monitoring and indoor air testing would be used to either verify the JEM predictions or improve the model.

2. The indoor air of the old farmhouse with the Michigan cellar should be tested to make certain that any concentrations of TCE are not of concern. The GVIIC is not applicable to this scenario; therefore, testing results cannot be used for JEM verification.

3. The soil should be retested for arsenic levels. Any subsequent soil remediation should be consistent with the proposed land use.

4. The developer, and any construction company he employs, should take "due care" measures while clearing and building on the property to prevent unacceptable exposure to TCE or arsenic of either construction personnel, neighbors, or future residents. Measures to consider include providing gloves and dust masks to the workers, laying down a vapor barrier before pouring foundation, removing the arsenic-contaminated soil in the northeast corner of the property, and modifying the construction plans for the site. The developer should confer with MDEQ to be certain regulatory requirements are met.

<u>Public Health Action Plan</u>

►The MDCH will request that MDEQ determine a site-specific GVIIC and consider soil-gas monitoring and indoor-air testing of existing homes over the plume. (These discussions are already under way.)
►The Douglas Health and Environment Committee will arrange for indoor-air testing of the old farmhouse immediately to the north of Chase. (Testing has been completed and results indicate no harmful levels of TCE in the house.)
►The MDEQ will oversee a Remedial Investigation and Feasibility Study and choose an appropriate remedial action. (The Remedial Investigation is complete.)
►The developer will take "due care" measures during construction activities.

New environmental data or information concerning the future use of this property may require future health consultations.

If any citizen has additional information or health concerns regarding this health consultation, please contact the Michigan Department of Community Health, Environmental and Occupational Epidemiology Division, at 1-800-648-6942.

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Table 1. Concentrations of trichloroethylene, cis-1,2-dichloroethene, and vinyl chloride in groundwater sampled from and near the former Miro Golf Course[1]

Chemical	Year	No. wells tested (no. detections)	Concentration range	MDEQ GVIIC (no. exceedances)	MDEQ GCC (no. exceedances)
Trichloroethylene	1988[2]	4 (4)	2-158,770	NA[3]	NA[3]
	1988[2]	1 (1)	180,000	NA[3]	NA[3]
	1989	14 (7)	ND-68,000	NA[3]	NA[3]
	1990	14 (8)	ND-42,970	NA[3]	NA[3]
	1993	9 (7)	ND-140,000	NA[3]	NA[3]
	2001	17 (10)	ND-81,000	15,000 (1)	37,000 (1)
	2002[4]	7 (4)	ND-16,000	15,000 (1)	37,000 (0)
	2002[4]	7 (5)	ND-14,000	15,000 (0)	37,000 (0)
Cis-1,2-dichloroethene	1989	14 (4)	ND-1,200	NA[3]	NA[3]
	1990	14 (4)	ND-1,622	NA[3]	NA[3]
	1993	11 (1)	2	NA[3]	NA[3]
	2001	17 (9)	ND-3,000	96,000 (0)	200,000 (0)
	2002[4]	7 (4)	ND-680	96,000 (0)	200,000 (0)
	2002[4]	7 (4)	ND-510	96,000 (0)	200,000 (0)
Vinyl chloride	2001	17 (4)	ND-53	110 (0)	570 (0)
	2002[4]	7 (2)	ND-6.3	110 (0)	570 (0)
	2002[4]	7 (3)	ND-6.5	110 (0)	570 (0)

References: MDEQ 2002, Weston 2002

Acronyms:

GCC	MDEQ Groundwater Contact Criteria
GVIIC	MDEQ Groundwater Volatilization to Indoor Air Inhalation Criteria
MDEQ	Michigan Department of Environmental Quality
NA	not applicable
ND	not detected
ppb	parts per billion

Notes:

1. All concentrations given in ppb.
2. First testing in 1988 performed 9/19/88. Second testing performed 9/29/88.
3. The GVIIC and GCC were first listed in the MDEQ Part 201 criteria in 1997.
4. First testing in 2002 performed 4/10-11/02. Second testing performed 4/24-25/02.

Table 2. Concentrations of trichloroethylene, cis-1,2-dichloroethene, and vinyl chloride in surface water sampled near the former Miro Golf Course[1]

Chemical	Year	No. wells tested (no. detections)	Concentration Range	MDEQ DWC (no. exceedances)	MDEQ GCC (no. exceedances)
Trichloroethylene	2001	6 (3)	ND-670	5 (3)	37,000 (0)
	2002	8 (6)	ND-370	5 (5)	37,000 (0)
Cis-1,2-dichloroethene	2001	6 (3)	ND-110	70 (1)	200,000 (0)
	2002	8 (6)	ND-71	70 (1)	200,000 (0)
Vinyl chloride	2001	6 (1)	ND-3.1	2 (1)	570 (0)
	2002	8 (5)	ND-5.6	2 (4)	570 (0)

Reference: Weston 2002

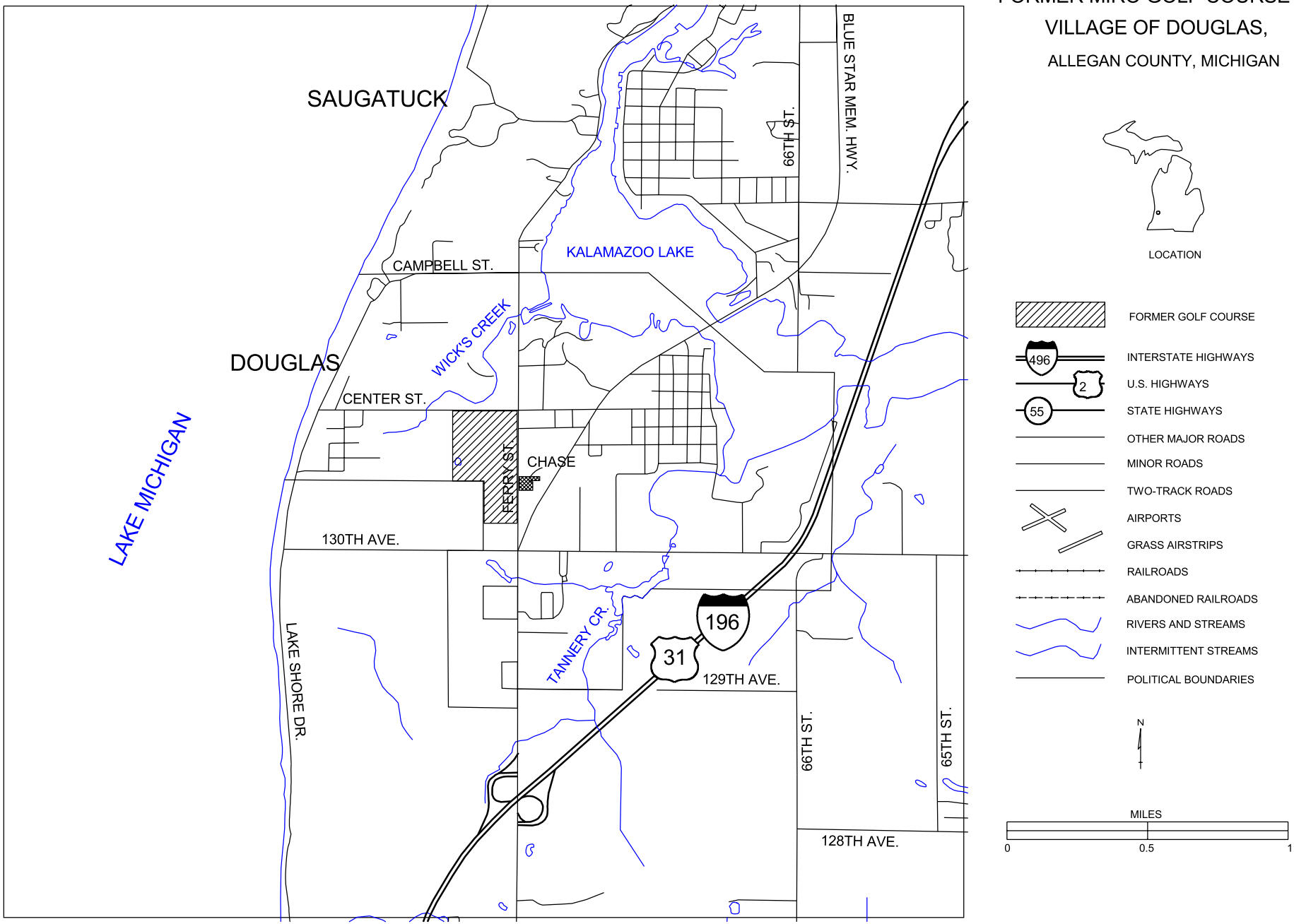
Acronyms:

DWC	MDEQ Drinking Water Criterion
GCC	MDEQ Groundwater Contact Criterion
MDEQ	Michigan Department of Environmental Quality
ND	not detected
ppb	parts per billion

Notes:

1. All concentrations given in ppb.

Figure 1.



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1/10/2003

Figure 2.

SOIL SAMPLING LOCATIONS FOR ARSENIC TESTING , THE FORMER MIRO GOLF COURSE

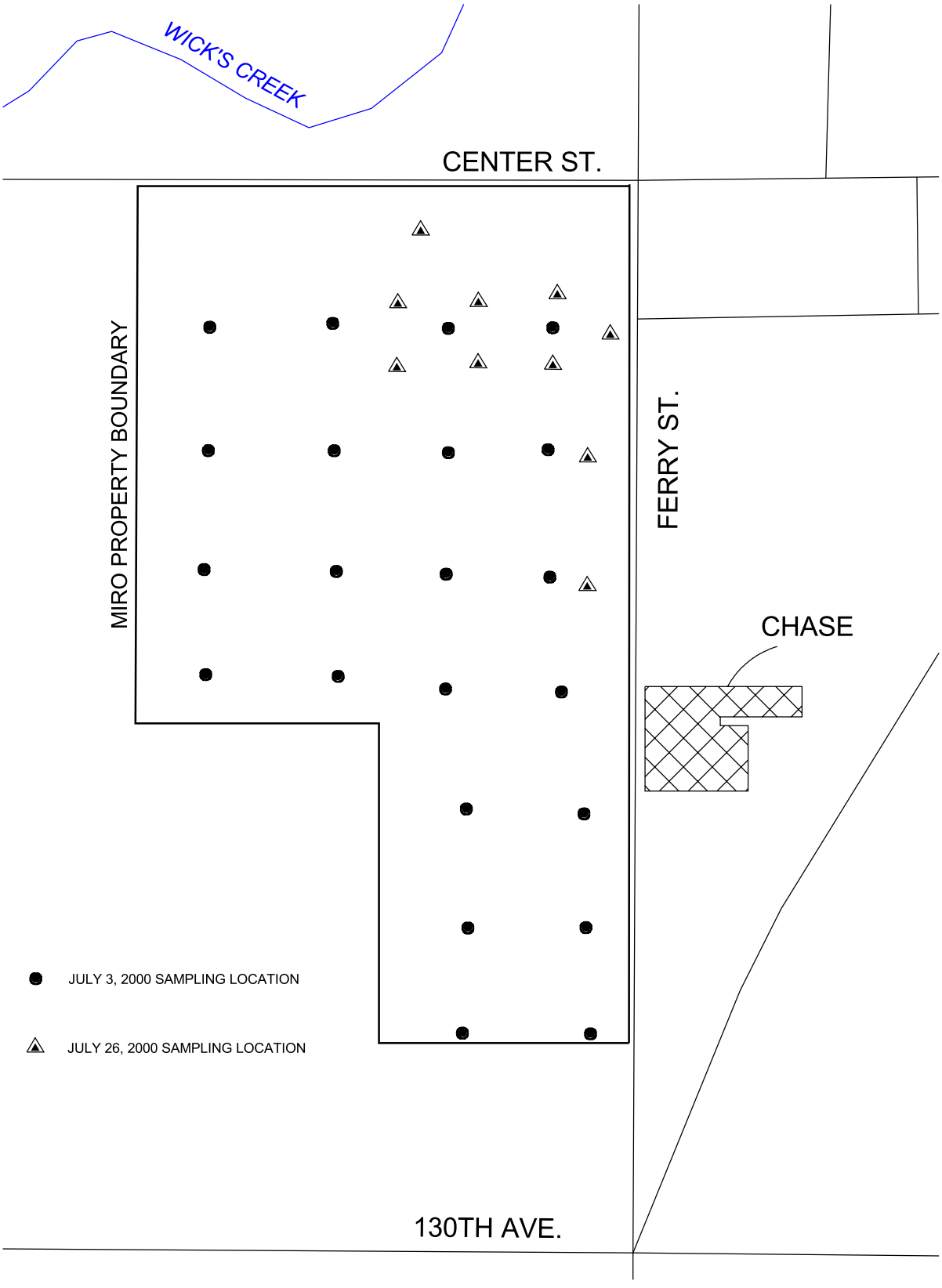


Figure 3.

"BEACHSIDE VILLAGE" PROPOSED DEVELOPMENT PLANS,

THE FORMER MIRO GOLF COURSE

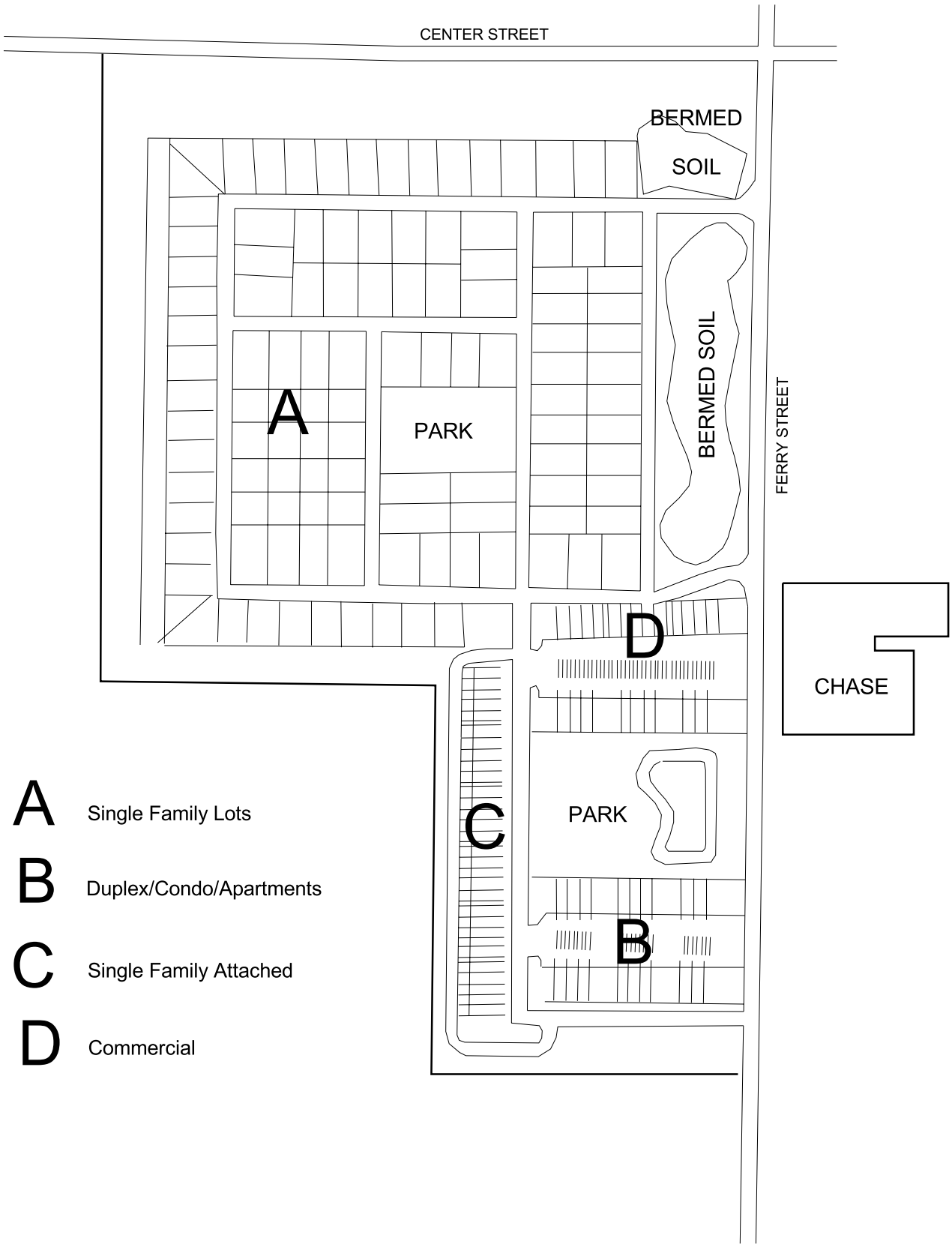
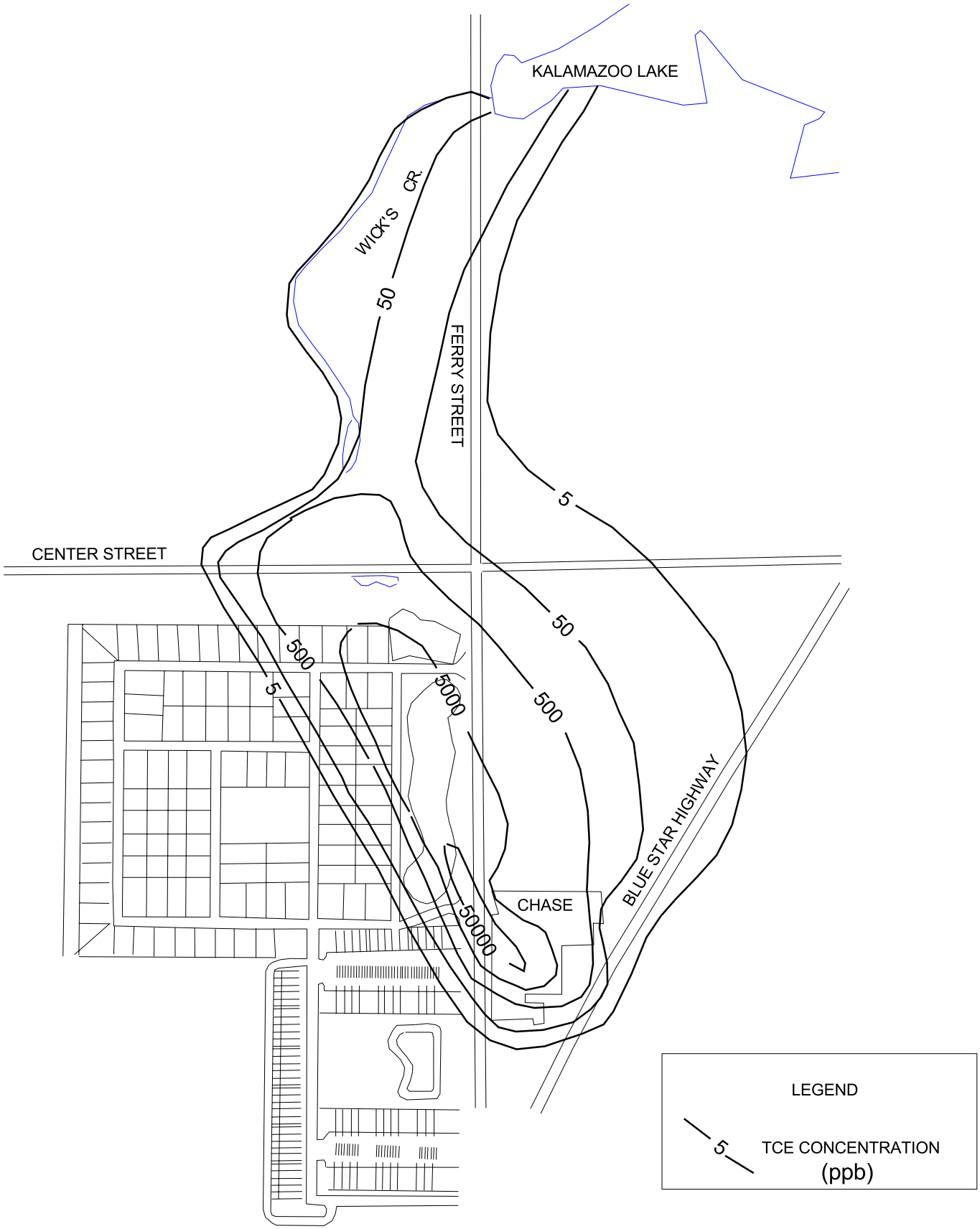


Figure 4.

TCE GROUNDWATER PLUME ISOPLETHS,

THE FORMER MIRO GOLF COURSE



Certification

This Former Miro Golf Course Health Consultation was prepared by the Michigan Department of Community Health under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodology and procedures existing at the time the health consultation was begun.

(Technical Project Officer, State Programs Section, SSAB, DHAC, ATSDR)

The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

(Chief, State Programs Section, SSAB, DHAC, ATSDR)